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Projects evaluation in construction industry

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ABSTRACT

The economic activity support in the construction industry in numerous developed countries is a percentage of about 5-11 of their GDP consumed yearly on different kinds of construction projects and associated activities. This paper attempts to evaluate the construction project under different circumstances and different periods. This paper was divided into several stages to accomplish its aim, the first stage, the researchers have gathered information about 30 projects in a different period starting from 2001 to 2017. The second stage included a questionnaire survey to get an indication of the importance of these factors. The third stage comprised analyzing the project's evolution using an artificial intelligence technique, which is a K-nearest neighbor classifier. The fourth stage included using the run chart technique to show the change in the evaluation of the project.

It can conclude that the project's evaluation is continuously fluctuated in different periods, the risks that occur have a direct relationship with cost and time overruns and indirect connection with project evaluation.

Keywords: Construction Industry, Project Evaluation, KNN, Run Chart

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1. Introduction

The economic activities support is the construction industry in numerous developed countries; there is a percentage of about 5-11 of their GDP which is expended yearly on various types of development extends and related exercises [1]. It was the essential mechanical foundation in Europe, with 30% of the workforce in 2007 [2]. The classes of the development undertakings can be as follows: designing development or mechanical development building development [3].The earth of the matter of the development venture will, in general, change quickly and intentionally all through the world. The issue will be raised because the associations failed to modify and react to new condition unpredictability [4]. Thus, the temporary workers must be able to improve their presentations not exclusively to the unpredictability yet, also the expansion of the necessities for the clients' ecological responsiveness and lack of assets on one side, and remarkable rivalry for the commercial center of development business on the opposite side [5].A numeral investigation has been built up to review the factors affecting the execution of the task in creating nations. [6] portrayed that workforce absence of abilities, modest course, and denied site of the executives, initiative that is inadmissible, needed and breakdown of gear between others take an interest in delays in the development of the United Arab Emirates. [7] contemplated reasons for the disappointment of the customers in the South African structure industry. They set up that battle, low workmanship, and temporary worker's ineptitude at being between the elements, which would unfavorably affect the execution of the undertaking. [8] perceived that quality and way to deal with the administration is one of the significant components making fruitful venture conveyance in South Africa.

The lack of performance regarding delays of time, quality, and increase in cost is usually in a construction project [9]. [10] proposed that time delays and increases in cost are mainly due to problems in payment, lack of management by the contractor, issues with material procurement, lack of technical ability, and material price escalation. On the other hand, several researchers have studied the leading causes of defects of quality. For example, [11] recognized as an effort of human and another of which [12] is labeled as poor workmanship.

These studies also participated in identifying quality, time, and cost as the three most significant signs to evaluate the performance of the construction project.

The development segment wasteful aspects start from, among various things, developing the expenses of development, battles, and customer dismay, the split idea of the business, little rivalry, and cost increment and postponements [13-17]. Expenses of Swedish lodging development have expanded more than the swelling rate through the most recent decade (1994-2004). In [15] reported to the British Department for Transport, he recognized that transport ventures are on a fundamental level which is dangerous because the long arranging skyline and composite task interface, that regularly instigates varieties related to dithering at the underlying undertaking stages, specialized norms, and states of the geotechnical aspects. Additionally, the nature that considers the split and present moment of development ventures joined with numerous partners with changed purposes makes it challenging to achieve the elevated levels and dependable quality [16].

[18] examined the change orders cost on 22 government development extends and builds up that change orders on these activities that are around 5.5% of the agreement's estimation.[19] set up in his examination that varieties in development undertaking can cost among 10-15% of the estimate of the agreement. [19] likewise settled Framework that has objectives to offer to undertaking change the board with an instrument that will permit development experts to consider and inspect the progressions that occur on ventures from motivation to result. To discover whether a change is conceivable and to decide an outcome that is good for all gatherings.

From the above, it can be concluded that several factors affect the performance of the project, which we can order them as follows, time overruns, cost overruns considered as the main contribution to the degradation in the project performance, therefore, this paper attempted to evaluate the construction project under different circumstances and different periods.

2. Material and methods

The paper was divided into several stages to accomplish its aim, the first stage, the researchers have gathered information about 30 projects in a different period starting from 2001 to 2017, it found that these projects have various factors which affect them during different times and their internal reasons and external reasons that effect the project's evolution.
The subsequent stage incorporated a poll overview to get a sign of the significance of these variables. The dispersion of polls was irregular, and tests were blended between proprietors, specialists, and contractual workers. Sixty structures were conveyed as follows: 20 to proprietors; 20 to experts; and 20 to temporary workers. Fifty were recognized. The example was approached to answer, relying upon their insight to acknowledge the factor influencing venture assessment on a five-point Likert scale as exceptionally high, high, medium, low, and very low. Depending on the appropriate response, the task separated into various zones relying upon the time of undertaking the conditions.
The third stage included analyzing the project's evolution using an artificial intelligence technique called a K-nearest neighbor classifier.

KNN is an algorithm of classification that was initiated by T.M. Cover and P.E. Hart. It is regularly used for future data classification because of its easiness, simplicity of employment, and efficiency. It is one of the highest algorithms between ten algorithms of [20] data mining that has been broadly useful in different arenas of pattern recognition, diagnosis of cancer, classification of text, etc.[20]

KNN is based on standard Euclidean distance to measure the change or likeness among instances of training and test. The standard Euclidean distance d (xi,xj) is defined in equation one as follows [21]:

$$d(xi, xj) = \sqrt{(ar(xi)ar(xj))^2} \quad (1)$$

KNN takes into consideration the highest typical class of k nearest neighbors to evaluate the type of test instance. It is defined in equation two as follows:

$$c(x)=\text{argmax}\sum\_(ci=1)\ ^k\ \delta(c,c(yi)) \quad (2)$$

The fourth stage included the use of the run chart technique to show the change in the evaluation of the project.

A run diagram is a quality measure line chart with time. The middle is uncovered as an even line isolating the information focuses such that half focuses are over the middle and half are under. The significant point of the run outline is to see process the advancement or procedure hardship, which will turn up as examples that is non-irregular in the information that focuses conveyance about the median [22]. The figure below showed the various shapes of the run chart:

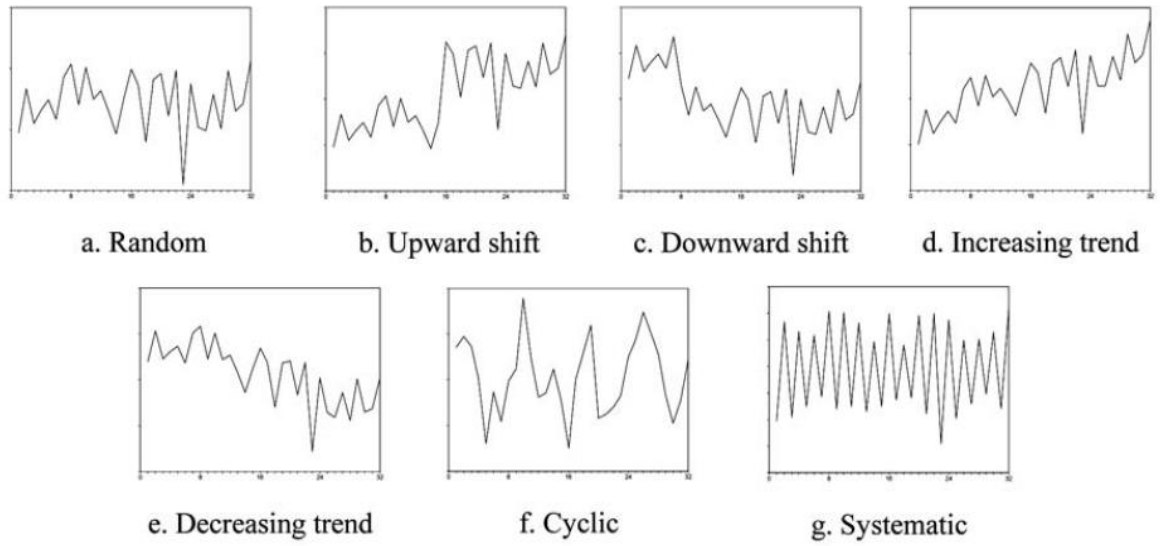

Figure 1. Run chart types [23]

3. Results and discussion

3.1. Project information

This part is related to the project information in different periods; the number of risks and the change order appeared differently in each project depending on its period. The risks that collected is shown in the table below:

Table 1. Projects Problems

Problems	Problems
Prices fluctuate	Wrong estimation
Inflation	Finical difficulty by the contractor
Increase in the cost of skilled labor	Quality control of the material
Delay in completing the project	Mismanagement of the contract
Labour productivity	Finical difficulty by the owner
Change in cost of equipment	Poor control of the contract
Luck of the labour	Special circumstances and excluded risks

After that, the researchers gathered information about the change orders in these projects, and they were as follows:

Table 2. Change orders and the cause of its appearance

Chang orders	The cause of this change
Addition of the work	Owner
Design error	Owner
Adjustment to the contract price	Contractor
Adjustment to the contract time	Contractor
Wrong estimation	Owner, Contractor
Change of plans by proprietor	Owner
Contractual worker's absence of judgment	Contractor

Chang orders	The cause of this change
Deletion of the work	Owner, Contractor
change in mind	Owner
Changes in specification and scope initiated	Owner
Demolition and re-work, Quality improvement.	Owner
Economy or legal issue	Beyond control owner, contractor
Rework	Owner
Modification to the design	Owner
Conflict between parties	Owner, Contractor
Change in the price of the market	Beyond control owner, contractor
Change in the regulation	Beyond control owner, contractor
Mystery of the contract	Owner, Contractor

From the above, we can notice the reason for the change orders is either the owner or the contractor or both of them, and sometimes the change occurs beyond the control of them.

3.2. Questionnaire survey

The researcher gathered additional information regarding cost overruns, time overruns, number of assignments, completion ratio, and the impact of the risks and the change orders. It is shown in the table below.

Table 3. Projects evaluation in different periods

date	No of assignment	No of Risk	qualitative impact	No of Change Order	cost overruns	time overruns	completion ratio	performance
2001	2	4	low	3	0.1	0.05	1	high
2002	2	7	medium	4	0.09	0.04	1	high
2003	2	13	medium	6	0.2	0.1	1	high
2004	2	7	medium	8	0.22	0.2	1	high
2004	2	15	high	10	0.21	0.26	0.9	high
2005	2	12	medium	7	0.3	0.28	0.5	medium
2006	2	7	medium	10	0.5	0.5	0.3	low
2006	2	12	high	12	0.65	0.6	0.4	low
2006	2	7	medium	10	0.7	0.67	0.45	low
2007	2	7	medium	19	0.3	0.5	0.9	medium
2007	1	10	medium	16	0.23	0.55	1	medium
2008	1	7	medium	15	0.2	0.45	1	medium
2008	1	7	medium	17	0.21	0.48	1	medium
2009	1	10	high	15	0.23	0.5	1	medium
2010	1	7	medium	15	0.25	0.4	1	medium
2011	1	7	medium	14	0.23	0.45	1	medium
2011	1	8	medium	15	0.27	0.5	1	medium
2012	4	12	high	18	0.3	0.48	1	medium
2012	1	7	medium	15	0.25	0.45	1	medium
2013	1	7	medium	13	0.24	0.43	0.8	medium
2013	1	7	medium	12	0.32	0.49	0.67	low
2014	1	8	high	10	0.44	0.55	0.15	low
2014	1	9	high	12	0.45	0.59	0.2	low
2015	1	10	medium	10	0.5	0.6	0.25	low
2015	1	12	medium	9	0.54	0.5	0.4	low
2016	1	7	medium	10	0.45	0.5	0.35	low
2016	1	9	high	9	0.41	0.6	0.3	low
2017	1	9	medium	10	0.45	0.7	0.35	low
2017	1	12	high	9	0.45	0.5	0.1	low

The researchers have a note from the survey that can note that the direct relationship between time and overruns, No of assignments, completion ratio with an evaluation of the project and indirect contact between the number of risks and change orders with an evaluation of the project, this relationship with more accuracy can be shown in the cause and effect diagram.
Ishikawa Diagram is otherwise called Fishbone Diagram. The name infers-structure its state of a fish skeleton. It was created by Professor Kaoru Ishikawa, who established the procedure of value of the board in the Kawasaki Shipyards during the 1960s. The fishbone chart or as a cause – impact outline. It helped to show the relationships regarding an impact and its different stylish objects. Fishbone chart demonstrated the potential reasons for an exact event or an issue [24].

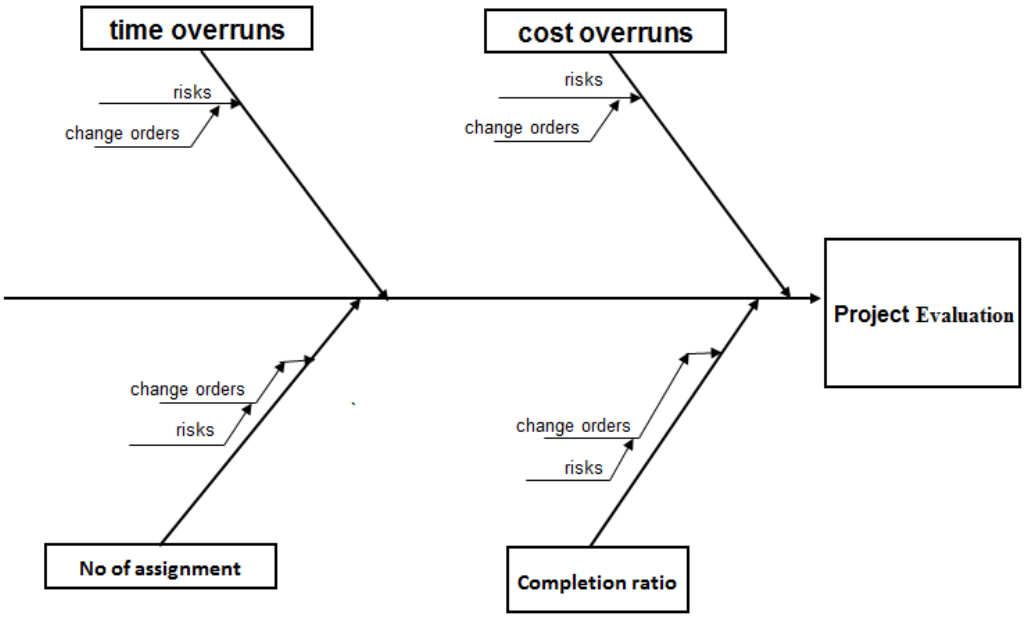

Figure 2. General cause and effect of the projects

The above is the general cause and effects diagram for all the projects in a different period; an example was taken from a single project to explain the idea.

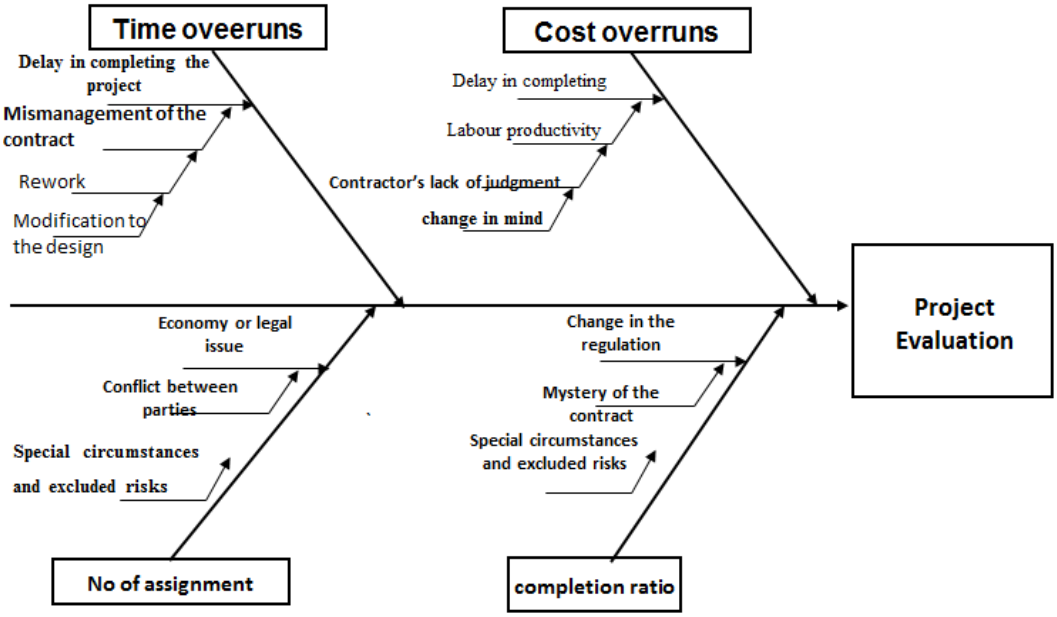

Figure 3. Cause and effect of the single project

3.3. KNN application

To analyze these projects, KNN was used to make sure of the evaluation of the projects and the accuracy of the technique.

Table 3. KNN results

Class	Recall	Precision	Sensitivity	Specify	F-mean	Accuracy	Cohen Kaapa
High	40%	100%	40%	100%	57%		
Medium	97.1%	100%	97.1%	100%	95.7%		
low	100%	75%	100%	76.1%	85.7%		
						86.2%	77.7%

The technique showed good accuracy in the analysis of the project's evaluation.

3.4. Run chart application

The researchers have used the run chart to show the development of the projects over the years; first, a single project was taken to the progress of the project.

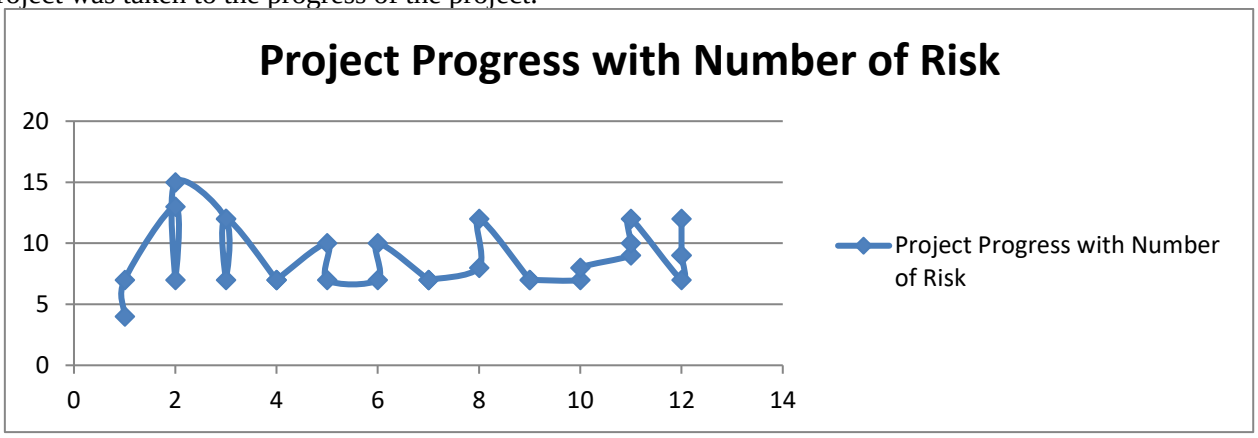

Figure 4. Run chart of project progress with number of risks

The figure above showed the number of the risks with the progress of the project, it can note that at the beginning of the project, the number of risks is very high and that goes to the fact that there is uncertainty about the project and continue to reduce until the end of the project, that showed that there is a shift in the project from one state to another.

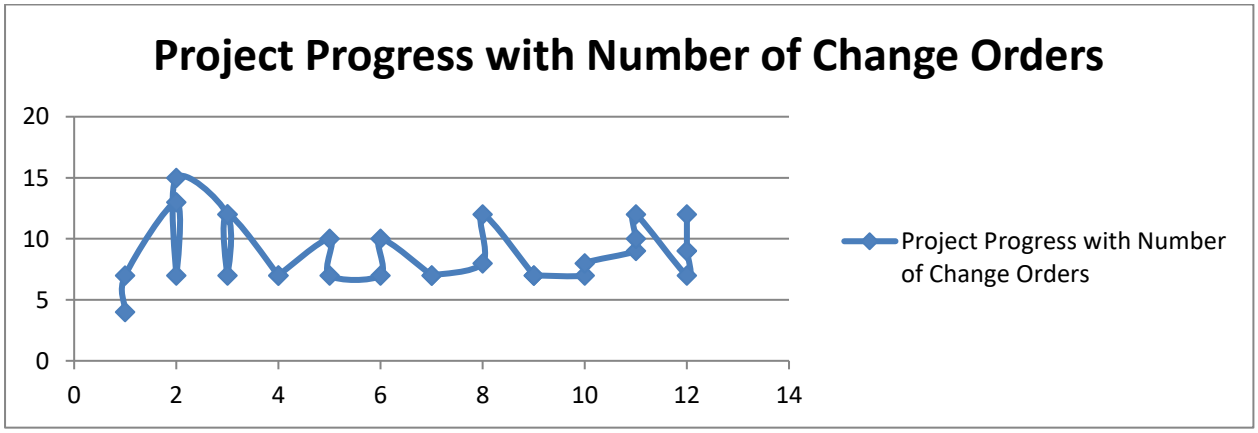

Figure 5. Run chart of project progress with number of change orders

The change order showed its highest number in the period from 3 months to almost 9 months, which is the project's execution, which means that the project has a trend towards increasing in this period. After that, the whole projects were taken to be implemented in the run chart.

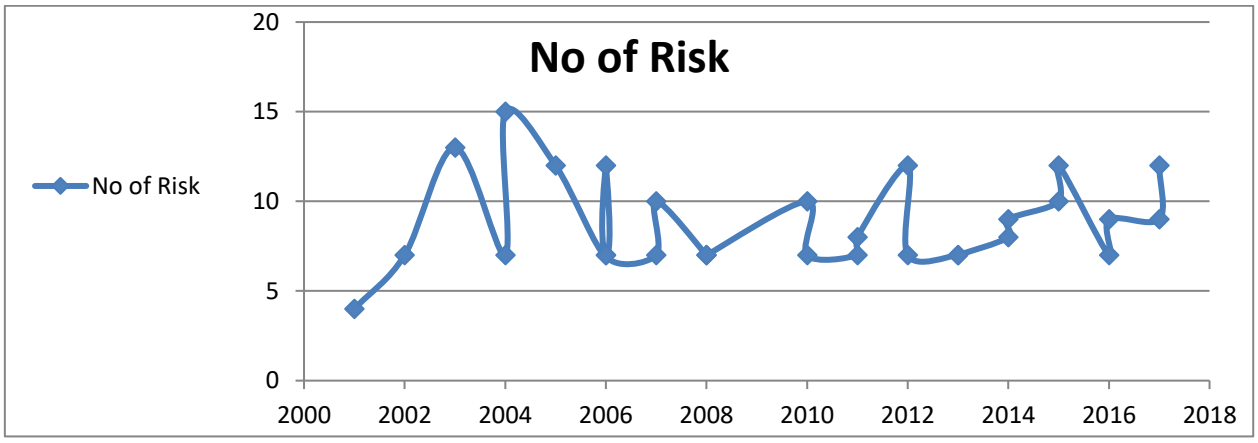

Figure 6. Run chart of project date with number of risks

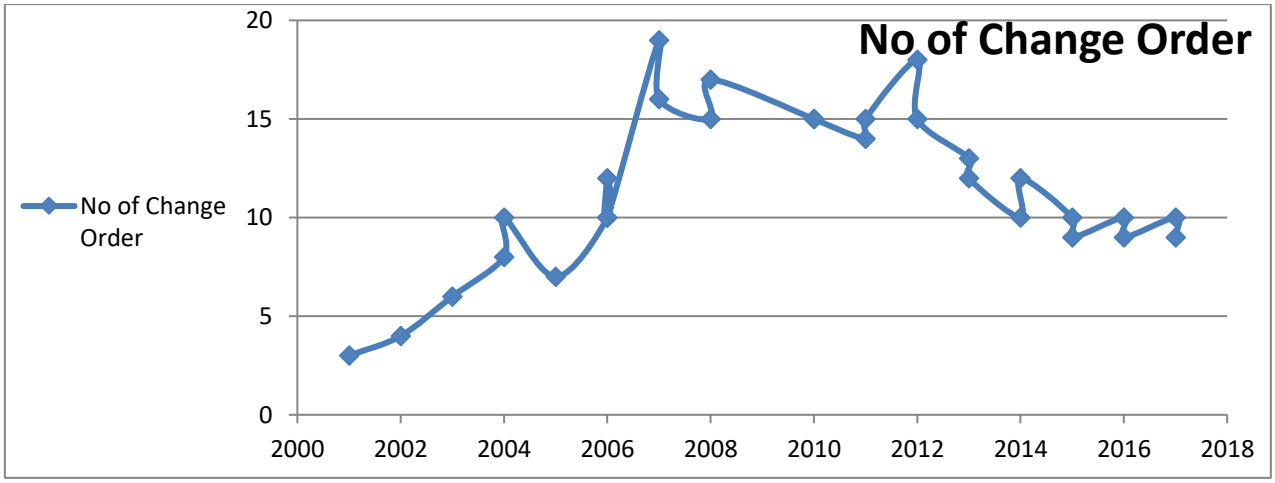

Figure 7. Run chart of project date with number of change orders

The two figures above showed the number of risks and change orders over time. It can be noted that the risks and change orders from the period of 2001 to 2003 were little that because the conditions were almost with no problems, while from 2003 to 2007, the risks arised very rapidly due to insecure situations, and from the period from 2007 to 2014, the change order increased due to the increase of the error and the demand of the owner. Finally, from 2014 to 2017, the number of risks and change order was high due to the country finical condition.

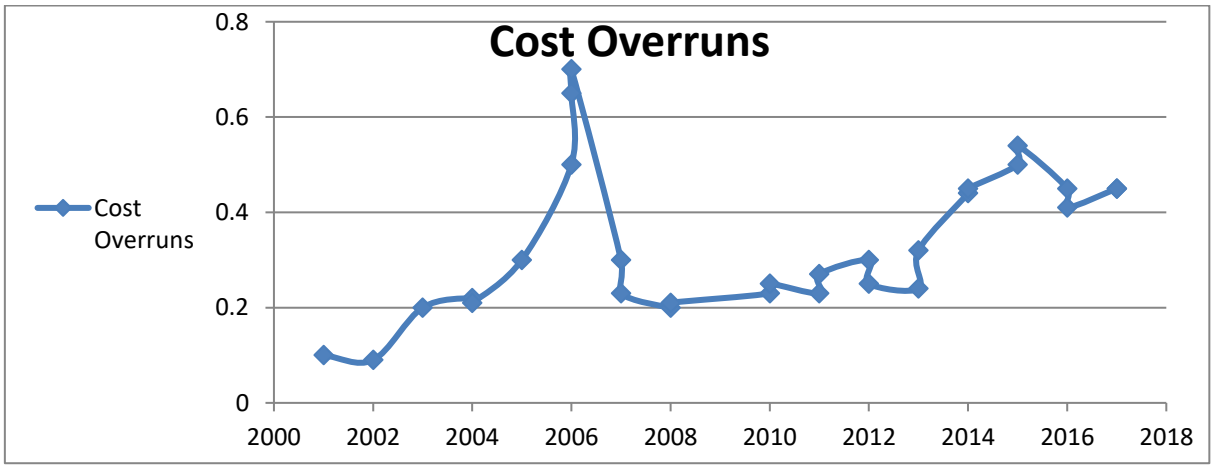

Figure 8. Run chart of project date with cost over runs

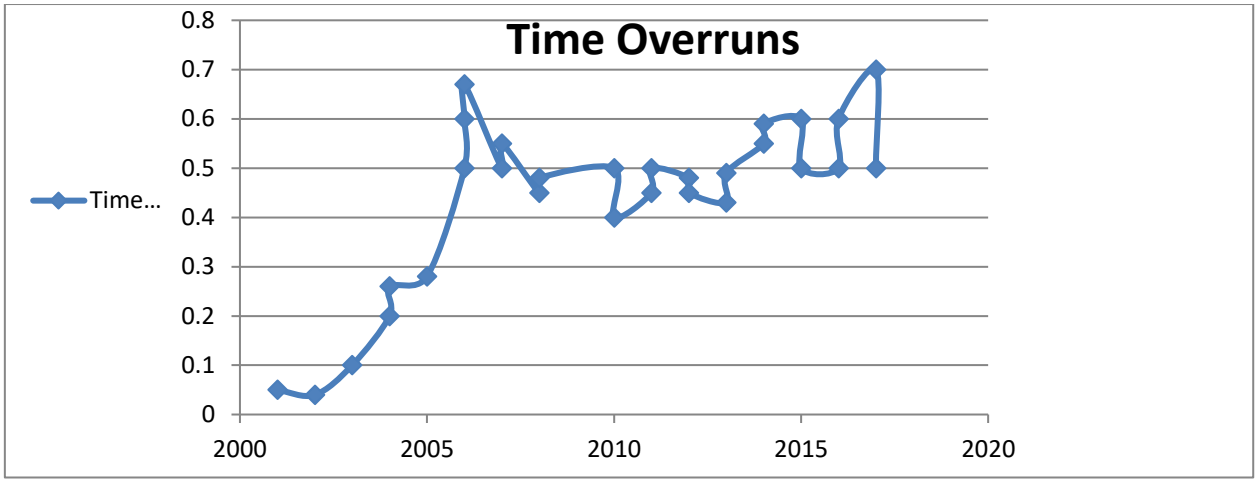

Figure 9. Run chart of project date with time over runs

The above show time and cost overruns and show behavior similar as we mentioned early.

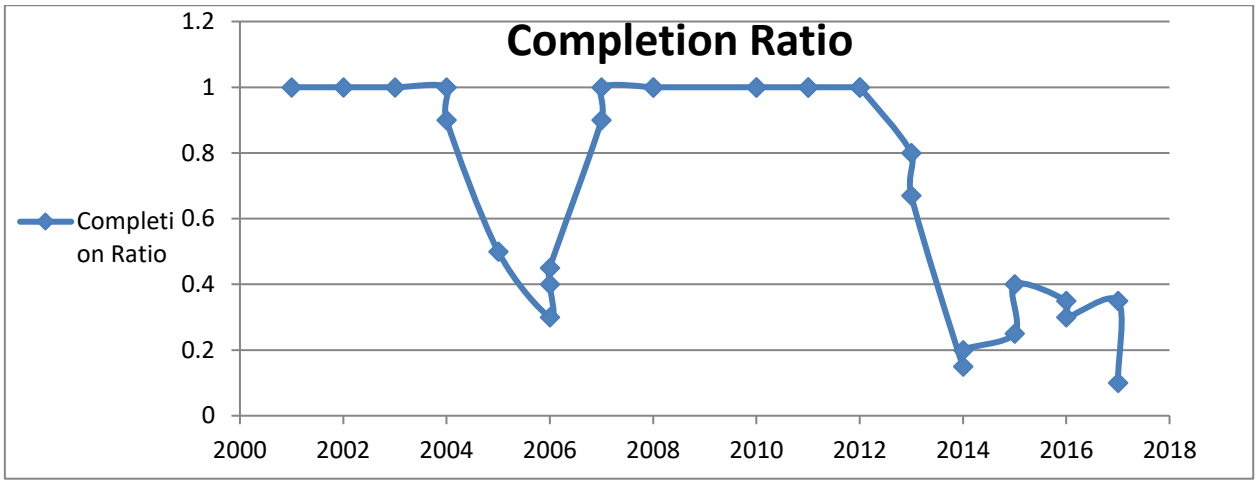

Figure 10. Run chart of project date with completion ratio

The figure above showed the completion ratio over the years, the projects are nearly completed until 2013 and 2017, the rate began to decrease due to the circumstance of the country from the finical and security aspect.

4. Conclusions

From the above results, it can conclude that the project's evaluation is continuous fluctuation in different periods. The risks that occur have a direct relationship with cost and time overruns and indirect connection with project evaluation.

The highest the risks the more the projects take time to treat these risks and more cost required to make the treatment process success, most of the risks were as results from the unstable situation for the country as is gone through the different condition, in 2001, the conditions are almost stable and without any problems. Still, in 2003, the war was waged against the country, and a lot of the issues increased, which reflect either as risks or change orders or both and led to increasing the time and the cost of the projects.

By 2006, there was a civil war in the most of the country and the projects are entirely or partially stooped and that led to numbers of risks and change orders and caused the projects evaluation to decrease when it comes to 2008, the conditions became better, and the state of the country began to return which showed excellent performance to the projects.

Again in 2014, As a result of the war waged by ISIS, there were finical and security problems that most reflected on the completion ratio, as nearly the highest proportion was 40% completion.

The cause and effects diagram showed an excellent ability to reflect the internal and external reasons that caused the fluctuation of the projects. The run chart can show the progress of the projects with time. On the other hand, the KNN has approved its power to analyze the projects.

References

[1] J. Bennett and E. J. J. o. p. e. Iossa, "Building and managing facilities for public services," vol. 90, no. 10-11, pp. 2143-2160, 2006.

[2] J.-L. Gálvez-Martos, D. Styles, H. Schoenberger, B. J. R. Zeschmar-Lahl, Conservation, and Recycling, "Construction and demolition waste best management practice in Europe," vol. 136, pp. 166-178, 2018.

[3] D. W. Halpin, G. Lucko, and B. A. Senior, *Construction management*. John Wiley & Sons, 2017.

[4] A. Lee, R. Cooper, and G. Aouad, "A methodology for designing performance measures for the UK construction industry," in *Bizarre Fruit Postgraduate Research Conference on the Built and Human Environment*, 2000.

[5] M. Samson and N. Lema, "Development of construction contractors performance measurement framework," in *1st International Conference of Creating a Sustainable*, 2002.

[6] A. S. Faridi, S. M. J. C. M. El-Sayegh, and Economics, "Significant factors causing delay in the UAE construction industry," vol. 24, no. 11, pp. 1167-1176, 2006.

[7] D. N. J. P. M. s. D. U. o. t. W. Hanson, "causes of client dissatisfaction in the south african building industry and ways of improvement: the contractors'perspectives," 2006.

[8] J. Mbachu, R. J. C. M. Nkado, and Economics, "Factors constraining successful building project implementation in South Africa," vol. 25, no. 1, pp. 39-54, 2007.

[9] T. Y. Lo, I. W. Fung, K. C. J. J. o. c. e. Tung, and management, "Construction delays in Hong Kong civil engineering projects," vol. 132, no. 6, pp. 636-649, 2006.

[10] Y. Frimpong, J. Oluwoye, and L. J. I. J. o. p. m. Crawford, "Causes of delay and cost overruns in construction of groundwater projects in a developing countries; Ghana as a case study," vol. 21, no. 5, pp. 321-326, 2003.

[11] A. R. J. S. S. Atkinson, "The role of human error in construction defects," 1999.

[12] P. E. Love, Z. Irani, and D. J. J. S. c. m. a. i. j. Edwards, "A seamless supply chain management model for construction," 2004.

[13] M. Latham, "Constructing the team: final report of the government/industry review of procurement and contractual arrangements in the UK construction industry," ed: Hmso, London, 1994.

[14] J. J. T. Egan and t. Regions, "Rethinking Construction. Department of the Environment," 1998.

[15] B. Flyvbjerg, M. K. Skamris Holm, and S. L. J. T. r. Buhl, "How common and how large are cost overruns in transport infrastructure projects?," vol. 23, no. 1, pp. 71-88, 2003.

[16] A. Toakley, M. J. E. Marosszeky, Construction, and A. Management, "Towards total project quality–a review of research needs," 2003.

[17] H. J. E. Lind, Finansdepartementet, Ds, "Bostadsbyggandets hinderbana: en analys av utvecklingen 1995-2001," 2003.

[18] J. E. Diekmann, M. C. J. J. o. c. E. Nelson, and Management, "Construction claims: Frequency and severity," vol. 111, no. 1, pp. 74-81, 1985.

[19] S. Senaratne and M. Sexton, "Managing construction project change in the knowledge age: a case study," in *20th Annual ARCOM Conference*, 2004, pp. 1-3: Citeseer.

[20] X. Xiao and H. Ding, "Enhancement of K-nearest neighbor algorithm based on weighted entropy of attribute value," in *2012 5th International Conference on BioMedical Engineering and Informatics*, 2012, pp. 1261-1264: IEEE.

[21] B. Sun, J. Du, and T. Gao, "Study on the improvement of K-nearest-neighbor algorithm," in *2009 International Conference on Artificial Intelligence and Computational Intelligence*, 2009, vol. 4, pp. 390-393: IEEE.

[22] J. Anhøj and A. V. J. P. O. Olesen, "Run charts revisited: a simulation study of run chart rules for detection of non-random variation in health care processes," vol. 9, no. 11, p. e113825, 2014.

[23] S. K. J. Q. T. Gauri and Q. Management, "A quantitative approach for detection of unstable processes using a run chart," vol. 7, no. 3, pp. 231-247, 2010.

[24] D. B. Septiawan, R. J. J. o. b. Bekti, and management, "Analysis of Project Construction Delay Using Fishbone Diagram at PT. Rekayasa Industri," vol. 5, no. 5, pp. 634-650, 2016.